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ABSTRACT

This digest provides information about "Research Within Reach: Science Education. A Research-Guided Response to the Concerns of Educators," part of a series produced by the Appalachia Educational Laboratory, Inc., Charleston, West Virginia. (Previous volumes in the series focused on reading, elementary mathematics, oral and written communication, and secondary school mathematics.) This information includes: (1) aim of the research within the series and document format; (2) topic areas considered in the four sections of the document (science education curriculum and goals, teaching and learning, a context for science education, and perspective papers); (3) comments on the document's eight chapters; and (4) concluding comments about the document along with several caveats. (JN)

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ERIC/SMEAC Science Education Digest Number 2

1984

A Review of "Research Within Reach: Science Education"

This digest is designed to provide ERIC/SMEAC users with some information about the most recent publication in the "Research Within Reach" series produced by the Appalachia Educational Laboratory, Inc., Charleston, WV. The focus on this volume is research in science education. Previous volumes in this series covered reading, elementary mathematics, oral and written communication, and secondary school mathematics.

Aim of the Research Within Reach Series

This series has been designed to help teachers become aware of research findings as these have implications for changes in practice. Available research is reviewed in interpretive report form, highlighting implications of research findings for classroom practice. Teachers' questions are used to provide a focus for chapter discussions of relevant research. Although each chapter is written by a different author or authors, some uniformity is maintained by following a model consisting of a question (or questions) asked by teachers, a discussion of research related to the question topic, a summary and a list of references arranged alphabetically by author and numbered. Reference numbers are used within the text for appropriate citations. Each chapter is written so that it may be read as a separate chapter. In this manner, teachers need read only that research of particular interest to them.

Topics Included in This Document

The science education volume is divided into four sections: curriculum and goals in science education, teaching and learning in science education, a context for science education, and perspectives papers. Each of these four sections is further subdivided. The curriculum and goals section contains two chapters. The first deals with curriculum development projects of the 1960s and the second, with goals of science education. The teaching and learning section contains four chapters: instructional strategies in the science classroom, evaluation of student progress, the integration of science and other school subjects, and computers and science teaching. The "context" section of the publication contains two chapters. One is focused on research related to the influence of school and home factors on learning. The other contains a discussion of science teacher preparation and professional development. The fourth and final section contains two perspectives papers.

Comments Related to Chapter Discussions

Although there are 60 citations for the first chapter, curriculum development projects of the 60s, the author of this chapter draws heavily on a group of recent meta-analysis studies for his discussion of these projects. Meta-analysis is a technique, popularized by Gene Glass of the University of Colorado, in which a group of studies on a related topic is analyzed to look for similarities and differences in findings related to this common topic. This analysis is accomplished by calculating a common measurement for each of the defined variables within a study to compare the magnitude of the difference between groups. This is referred to as "effect size." Effect size is obtained by subtracting the control group's score on each variable from the treatment group's mean score for the same variable and dividing by the standard deviation of the control group (pp. 9-10).

The chapter discussion provides support for the NSF-funded science curricula of the 1960s:

> . . . Evidence shows that students in such courses had enhanced attitudes toward science and scientists; enhanced higher-level intellectual skills such as critical thinking, analytical thinking, problem solving, creativity, and process skills; as well as, a better understanding of scientific concepts. Inquiry-oriented science courses also enhance student performance in language arts, mathematics, social studies skills, and communication skills (p. 20).

Much of the discussion in the second chapter refers to the findings of *Project Synthesis* and its four goal clusters related to students' future activities: personal needs, career education, societal issues, and academic preparation. Teachers are urged to incorporate all goal clusters into their instruction, not just the one for academic preparation. Thirty-nine references are found at the end of this chapter.

Chapter three, which begins the section on teaching and learning, has 25 references. These are used to provide a description of an effective science classroom as depicted through research. Students understand the carefully formulated objectives and receive feedback as they work to achieve these objectives through physical interaction with instructional materials whenever possible. Teachers ask fewer questions but they ask a variety in terms of the type of thinking the question is designed to elicit. If mastery learning is not adopted in this classroom, some of its features are: formative testing and a variety of remedial activites for students who need them.

The fourth chapter, on evaluation, has 39 citations. This chapter is uneven. Its author has attempted to cover many topics, each of which merits more discussion than printing space probably allows. There are brief discussions of skills that can be measured in science, of strategies that can be used to evaluate students' science skills, of resources available for selecting tests, and of students' interest in, and attitudes toward, science. There is a very brief discussion of what to do with the evaluation data once these have been collected. The author said (p. 60), ". . . Few teachers have been thoroughly trained in testing and evaluation . . ." Eliminating this deficit is beyond the scope of a single chapter in a review of research. However, some of the documents identified in the list of references are useful resources for teachers.

The authors of chapter five reviewed 128 pieces of literature focused on the examination of possible relationships between science and other school subjects. The relationship of science to reading, to mathematics, to social studies, to fine arts, and to health is described. Curriculum specialists and science educators interested in teaching science to

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elementary school students in settings in which science is integrated with other subjects should find this to be an interesting chapter.

Chapter six highlights research related to the use of computers and other technology in science classrooms. Sixty-one citations are located at the end of this chapter. The author of this chapter is of the opinion that "Research that specifically addresses microcomputer applications in the science classroom is not abundant . . ." (p. 109), so he chose to focus on

> . . . some basic issues surrounding educational computing in the science classroom. Issues discussed include: computer literacy for science teachers and their students; the effects of current technologies on curriculum and the need for reform; the effectiveness of the microcomputer applications in science classrooms; and the implications for the future of microcomputing in science education (p. 110).

Computers are used in science education for computer-assisted instruction, simulations and games, and specific problem solving activities. Computers may also be used for enrichment activities. There is a possible side benefit from computer usage in that students' verbal skills may be developed as a result of having to be precise when communicating with a computer. One of the present handicaps in the use of computer technology is that the development of hardware and software has not been parallel: hardware is relatively sophisticated but software is often of poor quality (pp. 115-117). The author also admonishes readers that

> It is important to realize that many current applications of microcomputers are answers to *old* problems. The potential of microcomputers to solve problems of which we are only vaguely aware or to extend our capabilities in new ways is great. While microcomputers can help science students simulate natural phenomena in controlled settings, this technology has much broader and deeper applications for all aspects of education (p. 117).

Chapter seven, the first of the two in the section entitled "A Context for Science Education," is focused primarily on some of the effective schools research and draws largely on literature related to the "Focus on Excellence" project of the National Science Teachers Association and other professional education associations. The author differentiates between microeffectiveness studies, in which the classroom is the unit of investigation, and macroeffectiveness studies, in which the school is the unit of investigation and analysis. Eight characteristics of schools with exemplary science programs are identified and discussed: (1) teachers develop their own curricula and are not textbook bound; (2) there is more emphasis on laboratory work than on lectures in science classes; (3) teachers use a variety of resources in planning for instruction — other teachers, science coordinators, university faculty, inservice, professional organization meetings, journals; (4) science teachers hold high self-expectations; (5) science teachers provide both a stimulating environment and an accepting atmosphere for their students; (6) they challenge their students and have differentiated expectations for them; (7) they possess effective communications skills, and (8) they stress the development of higher level intellectual skills (p. 126). The reference list contains 58 citations.

Chapter eight, the second one in the context section, is focused on science teacher preparation and the question of whether (or not) there is a shortage of science and mathematics teachers. Forty-one citations are listed.

The two perspectives papers stand in contrast to each other and to the other chapters in this volume. They were not written in response to research related to teachers' questions but from points of view that the authors hold. Welch's paper begins with his assumption that the methods for *learning* science should be the same as the methods for *doing* science (p. 161; italics, mine). He discusses what the science program should look like if science education should imitate science. In this writer's opinion, this is one of the more useful chapters in this volume — particularly for a classroom teacher who is interested in improving his/her science program and in countering some of the criticisms of reports about the deplorable state of science education.

Champagne and Klopfer offer the reader an alternative to the behavioral and the developmental views of teaching and learning. They discuss cognitive psychology, writing that cognitive scientists use computational metaphors to theorize about human cognition — the computer as a metaphor for the mind, computing as a metaphor for thinking, and data structures, for the knowledge in memory (p. 171). Champagne and Klopfer are of the opinion that cognitive psychology will have ". . . major impact on the practice of science education in the 1980s and beyond. . . ." (p. 171). Teachers at all levels should read their discussion of "naive theories" (pp. 181-186). The authors emphasize, "When we teach, we assume students interpret text, lectures, and experiments as we intended them to be interpreted. The evidence is accumulating that this assumption is often not valid" (p. 186). Twenty-nine related references are listed.

Some Concluding Comments, Caveats

The intention behind the *Research Within Reach* is a praiseworthy one. Most classroom teachers are so involved in meeting their day-to-day obligations that they have little, if any, time for research. If research findings are to have any impact on classroom practices, classroom teachers need to know what these findings are.

However, this review, like any other, comes to the reader after passing through several filters. One filter was the questions chosen to serve as topics for discussion of relevent research. Another filter was whatever process was used to identify the research studies sent to the chapter authors for review. Still a third filter is composed of the expertise, and the perspectives, of those individuals who served as chapter authors. As a result, the research that is within reach (contained in this volume) is a sample of that available. Readers who are not conducting their own independent searches of the literature have no way of knowing what was not included.

Readers interested in a particular topic, or finding should make a point of reviewing the original source. Basing their actions or decisions on the reviewer's remarks may, or may not, be a way to proceed. For example, in the chapter on evaluation, readers are cautioned about using ". . . tests developed as part of the innovative movement in science education . . . In many cases, the standard psychometric procedures that characterize good test construction and that mark standardized tests as different from other teacher-made tests were not followed. . . ." (p. 70). This cautionary note is based on an article, published in the *Journal of Research in Science Teaching* (JRST), whose author examined articles published in JRST and *Science Education* in which the relationship of test items to instruction were reported. While the concern is a valid one, its discussion in the context of the chapter may cause readers to avoid any test that is not a standardized one.

The fact that chapters were written to stand alone results in repetition for persons who read the entire volume. It also eliminates the opportunity for chapter authors to compare and contrast their particular topic with other topics within the volume.

REFERENCE

Holdzkom, David and Paula B. Lutz, editors. *Research Within Reach: Science Education.* A Research-Guided Response to the Concerns of Educators. Charleston, WV: Research and Development Interpretation Service, Appalachia Educational Laboratory, Inc., 1984. SE 044 774

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